Is There a Skills Crisis?

Trends in Job Skill Requirements, Technology, and Wage Inequality in the U.S.*

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INTRODUCTION

A leading explanation for the recent growth of inequality attributes this growth to a widening gap between the demand for and supply of worker skills. The question has an interesting history.

In the 1970s sociologists argued that employers' excessive hiring requirements were causing American workers to obtain more education than their jobs really required (Berg 1971; Collins 1979). Economists reported that an oversupply of well-educated workers had driven the college-high school wage differential to historic lows, with moderate prospect for improvement in the 1980s and 1990s relative to earlier levels (Freeman 1976, 73ff.). Policymakers wondered how they could make work more satisfying as the complexity of jobs at all levels failed to grow as rapidly as workers' educational levels and aspirations for meaningful work (U.S. Department of Health, Education, and Welfare 1973). More controversial, Harry Braverman's deskilling theory raised the prospect that the skill content of most jobs was actually declining, even as individuals' educational attainment continued to rise (Braverman 1974). Still, despite differences in detail, most agreed there was a glut of high skilled workers relative to the number of jobs that could fully utilize them.

What a difference a decade makes. In the 1980s the balance of opinion among sociologists shifted to the view that technology was increasing the relative number of high skill jobs, consistent with Daniel Bell's theory of an emerging information society (Bell 1976; Form 1987; Attewell 1987; Wright and Martin 1987). Policymakers were so alarmed at the failure of schools to keep up with the economy's need for skills that they compared the education system to a security risk (U.S. National Commission on Excellence in Education 1983), established commissions to clarify the skills that all workers needed (U.S. Department of Labor, 1991), and authorized new programs to set national occupational skill standards and improve the transition from school to work. Sociologists argued that an increasing mismatch between employer requirements and workers' skills was a principal source of minority worker disadvantage in the labor market (Wilson 1987). Economists studying the large growth in wage inequality in the 1980s concluded that the rising payoff to education reflected a more general imbalance between the growth of the supply and demand for skilled labor due to technological shifts (Katz and Murphy 1992). The demand for skills suddenly seemed to have raced ahead of supply. In just a few years glut turned to serious shortage, even more remarkable since most workers in the 1980s were the same as those in the 1970s.[1]

But is it true? Is the growth in inequality in the 1980s attributable to historically large shifts in job skill requirements favoring the more skilled? The dramatic growth of computers and microelectronics gives the argument plausibility, but the question resists easy answer. Trends in wage inequality are readily documented, but trends in job skill requirements and technology diffusion are not easily measured and even when measures are available there are difficulties in establishing a causal relation to changes in wages and skill requirements.

This paper examines available measures of skills and technology to shed light on the question of whether the growth of a skills gap can account for the growth in wage inequality and whether technology can be identified as playing a role in raising job skill requirements. In general, results indicate that skill requirements rose secularly between the early 1960s and late 1990s but show little evidence of the kind of acceleration that could explain the early 1980s surge in inequality. The relationship between skill and trends in wage inequality, on the one hand, and computer use and other similar kinds of technological change, on the other, is ambiguous at best.

The rest of the paper is structured as follows. The first section reviews existing research. The second section describes the data and measures. The third and fourth sections examine trends in educational attainment, occupational status, and computer use. A final section concludes.

[1] For instance, about 78% of household heads and spouses employed in 1985 reported at least nine years actual work experience in the Panel Study of Income Dynamics (author's tabulations). Although this figure does not include young adults in the labor force who still lived with their parents it gives a general sense of the overlap between the workforce in the mid-1980s and the mid-1970s.

THE DEBATE OVER SKILL-BIASED TECHNOLOGICAL CHANGE AND INEQUALITY GROWTH

Observing the substantial growth in inequality since the late 1970s, neoclassical economists argued that technological change increased the relative demand for skills to the point of scarcity, leading to a rise in the relative wages of the more skilled. Initially, the argument was based simply on the observation that after the returns to education fell to historically low levels in the 1970s, they rose to historically high levels in the 1980s, even as the share of high education workers employed within industries continued to rise (Katz and Murphy 1992). A simultaneous rise in the wages and employment of skilled labor implies increased demand in the standard neoclassical/human capital framework and the unobserved cause was simply ascribed to technology.

Subsequent work sought to provide more direct evidence for this hypothesis by showing that those using a computer at work earn significantly more than otherwise similar workers (Krueger 1993), computer investment is positively associated with the employment and wage bill shares going to non-production workers within manufacturing (Berman, Bound, and Griliches 1994, 387ff.), and changes in the share of workers using a computer at work are positively associated with changes in the share of more educated workers employed within industries (Autor, Katz, and Krueger 1998, 1189ff.). Even after controlling for overall capital intensity computer investment is positively related to higher skilled workers' share of the wage bill (Autor et al. 1998, 1196ff.). This research seemed to provide strong evidence that technological change, particularly from computers, shifted demand in favor of more skilled workers and widened the wage gap between skill groups.

However, there are reasons to question whether technologically-induced skill shifts explain the growth in wage inequality. Roughly half the growth in overall inequality is within education-experience-gender groups and almost no study can convincingly account for this portion of growing inequality. Krueger's finding that computer use is associated with large wage premia and explains a large portion of the growth in educational premia has also been found wanting (DiNardo and Pischke 1997; Handel 1999).

With respect to the broader issue of whether computers and other advanced technology have altered the composition of employment, Mishel, Bernstein, and Schmitt acknowledge that technology has decreased the demand for less skilled workers over time but point out that this was always true. Explaining the exceptional growth in inequality in the 1980s requires an acceleration in the rate of skill-biased technological change (SBTC), in their view. Yet few measures of productivity show faster growth during the 1980s relative to earlier decades and most studies do not compare technology's effect on wages in the 1980s with effects in other decades. Mishel et al. perform such comparisons and find that both computers and non-computer capital equipment generally do not show greater association with educational upgrading and wage inequality within industries in the 1980s relative to the 1970s. They also note that both the supply of and the wage premium for more educated workers stopped growing in the 1990s, which would not be expected if technology were consistently increasing the demand for more educated workers (Mishel and Bernstein 1994; Mishel, Bernstein, and Schmitt 1997).

In a similar vein, Howell pointed out that almost all of the shift in the composition of manufacturing employment toward non-production workers occurred during the 1979-1982 recession, rather than continuing during the rest of high tech 1980s (Howell 1994). Similarly, Howell and Wolff (1991) find that shifts in job skill requirements were more rapid in the 1960s than in either the 1970s or early 1980s. Autor et al. (1998, 1,194-1,195) do find evidence that computer use is associated with faster educational upgrading within industries after 1990, but inequality was relatively stable during this time, as will be shown below, and Autor et al. themselves conclude that the growth in demand for skilled labor fell to among the lowest level in the postwar period.

It should also be noted that when Autor et al. (1998, 1,194) perform a sensitivity analysis they find that the increase in computerization within industries between 1984-1993 is associated with an increase in the college wage bill share between 1970-1980 that is very similar to the increase between 1980-1990. This suggests that industries which increased their computer usage most in the 1980s were already upgrading the educational levels of their workforce for other reasons prior to computerization and that the computer coefficient may be biased. Even if one argues that the variable measuring growth in computer usage between 1984-1993 is picking up a common underlying technological change variable in the 1970s and 1980s, the similarity of the coefficients suggests no evidence of acceleration of skill-biased technological change in the 1980s.

These criticisms raise the possibility that although automation and the computer revolution are intuitively appealing as explanations for the growth of inequality, the role of technology in the recent period may be less distinctive than either casual reasoning or recent economists' arguments might lead one to believe.

The criticism has prompted a somewhat curious response from neoclassical economists associated with the skill-biased technological change argument. Even some early statements acknowledged some uncertainty over whether the skills shortage reflected acceleration in the demand for skills or constant demand growth combined with deceleration in supply growth (Katz and Murphy 1992, 50,69), though others seemed more certain that there was little distinctive about demand growth during either the 1970s or 1980s relative to earlier decades (Murphy and Welch 1993). Studies with direct measures of technology agree that the growth of overall capital intensity in manufacturing did not accelerate during the 1980s, although computer investment did so (Berman et al. 1994, 374,384f.; Autor et al. 1998, 1,196). Autor et al. (1998, 1,177ff.) conclude that while demand for college graduates accelerated in the 1980s, deceleration in the relative growth of supply was more important for inequality growth during this period. Indeed, they note with some surprise that, by their measures, growth in demand for college graduates actually decelerated in the 1990s to levels lower than any other time since the 1940s, despite continued growth of computer investment. Likewise, Berman et al. note that during the 1950s there was an employment shift in manufacturing toward non-production workers comparable to that during the 1980s and suggest "we avoid exaggerating the uniqueness of the computer revolution" (1994, 392-393.). A recent review article favorable to the neoclassical position seemed to summarize the state of the debate when it responded to Mishel and Bernstein's work by concluding simply that either an acceleration in demand or deceleration in supply would be sufficient to support the neoclassical view and left the matter at that (Gottschalk and Smeeding 1997, 649-650).

The various treatments leave the issue of the role of technology and skill demand rather unsettled. Here it is sufficient to note that if the slowdown in the growth of the relative supply of more educated workers becomes the preferred neoclassical explanation for the growth in wage inequality, then the issue becomes one of the small size of recent cohorts entering the labor market, the higher levels of educational attainment among recent retirees, which has reduced the size of the educational disparity between cohorts entering and exiting the labor force, and, perhaps less important in terms of magnitude, the failure of educational attainment to continue to rise rapidly within recent entering cohorts. In short, the issue becomes mostly one of demographics rather than anything particularly distinctive about the information age. This may be where neoclassical opinion eventually comes to rest, but it is very different from the conclusions most have drawn from this line of research, whose technology focus has naturally attracted the most attention. Indeed, insofar as the declining growth in educational attainment simply reflects small cohort size, the argument is more a variation of Richard Easterlin's (1980) well-known predictions of the future fortunes of the Baby Bust cohort, except that in this case the benefits of small cohort size flow only to the more-educated and spill over to similarly educated workers in older cohorts, while younger less-educated workers fall behind. If the demand shift favoring more skilled workers is not an accelerating one, then the explanation for inequality growth among both education and age groups reduces to a matter of fluctuations in cohort size in this explanation—Easterlin with a twist.

The following will focus most on the aspect of this debate that has received most attention, whether there has been an acceleration in the demand for skill and whether technology is a plausible candidate to explain any observed shift, but will also consider the issue of the slowdown in supply growth.

But this still leaves some uncomfortable issues remaining. Intuition would suggest that if information technology accelerated the trend toward skilled labor one would see such a development beginning in the mid-1980s and presumably continuing into the present, as the falling cost, rising functionality, and greater ease of use of information technology (IT) continued apace. However, as will be shown, the greatest growth of inequality and reduction of blue collar manufacturing labor occurred in the early 1980s, before computers were widely diffused, and the temporal pattern of job loss for other occupations vulnerable to automation does not fit the expected pattern either. Autor et al.'s (1998) own finding that the growth of demand for skill decelerated during the 1990s to levels unseen since the 1940s only further complicates matters. In other words, if one does believe that skill-biased technological change is the cause of inequality growth, it is still unclear when we should expect to see evidence of such acceleration.

Temporality is not the only area of the argument that suffers from a certain vagueness. There is also little specificity regarding the kinds of skills that technology has made more important. Though presumably the new skill demands are cognitive rather than interpersonal, there is no clear statement as to whether those in short supply are basic tenth grade reading and math skills among the less skilled or the higher order skills of knowledge workers with four or more years of college. The literature also does not offer a clear hypothesis for why one would expect one or the other to be especially in demand. In short, the issue of which skills are increasingly demanded has barely been broached.

There is also a lack of detail regarding the causal mechanism by which technology affects skill requirements. In the sociological debate on skills, Spenner (1988) has been careful to distinguish skill shifts resulting from within-occupation changes in the task content of work and between-occupation changes in the composition of the workforce. In other words, technology or other forces can affect the overall demand for skills by either changing the occupational composition of employment or changing the skill requirements within jobs. The economics literature has generally not made this distinction and the result has the potential for some confusion. For instance, Berman et al.'s work on the changing share of non-production workers in manufacturing is consistent with longstanding ideas about automation replacing less skilled labor with machines, while Krueger's work on the premium to computer use, a within-occupation trend, is consistent with the idea that more advanced technology requires higher levels of skill to operate. Both are theories of skill-biased technological change, but the causal mechanisms are quite different and if this is not recognized it is easy to confuse debates regarding one with the other.[2]

This does not exhaust the ways technology may alter skill requirements. New technology may increase the need for more skilled labor, such as technicians and system administrators to maintain the new technology or analysts to sift through the information it produces. The addition of workers at the top of the skill distribution is an alternative between-occupation shift to the elimination of less skilled workers at the bottom through automation. New technology may also raise skill requirements by making it easier for employers to assign more complex tasks to existing jobs, a different within-occupation shift than one resulting from the need to learn to use the equipment itself. For example, learning spreadsheet programs may not be difficult in itself but new bookkeeping tasks may require secretaries to have better math skills. Alternatively, it may be simply that the increased quantity and variety of information resulting from computers in the workplace raises the level of general intellectual flexibility required for both computer users and non-users (Levy and Murnane 1996.).

Whatever the hypothesized mechanism(s), it is evident that the economics literature lacks a clear statement of what specifically is being tested. The underlying mechanism by which technology drives shifts in demand for skill remain undertheorized in favor of a more “black box” approach. This paper considers both between- and within-occupation skill shifts, using direct measures of technology where possible. Before considering the data it should be said that there is a large and disparate literature which has tried to measure directly employers' demand for and workers' stock of skills and whether there is a gap between them. Most of this work has been stimulated by debate within the policy and educational research fields. An extensive review of these studies, available from the author, does not yield unambiguous evidence of a skills shortage.[3] Some of this is due simply to the cross-sectional nature of the studies, but much of the ambiguity results from the findings themselves.

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[2] Matters would only be further complicated if trends in management practices, such as high performance work practices, were lumped with capital equipment into a single, undifferentiated category called "technology," as some economists propose (Harry Holzer, personal communication).

[3] The studies reviewed include Rosenbaum and Binder (1997), Holzer (1996), U.S. Department of Labor (1992), Constantine and Neumark (1996), results from the National Adult Literacy Survey and the National Assessment of Educational Progress, National Center on the Educational Quality of the Workforce (1994), Cappelli (1992),

The studies suggest that many employers have basic literacy requirements even for jobs filled by less educated workers and are dissatisfied with the quality of their employees and their applicant pool. But it is not at all clear that the principal problem is a shortage of cognitive skills, either basic or high-level, rather than work attitudes. This is the case even though measured skill levels in the population can be surprisingly low, though not actually declining over time, and employers report that their skill needs have increased, though by how much is hard to say and no comparative evidence for earlier decades is available. Nor is it clear how much of any problem as exists is restricted to young workers, who may subsequently acquire the necessary attitudes and skills on the job. The results do not suggest computer skills are in particularly short supply, despite the technology focus of much of this debate, nor is there evidence of a general shortage of other technical or high-level skills. Finally, since most of these surveys are cross-sections from the 1990s, there is no way to know levels of employer dissatisfaction with worker skills in the 1980s, when inequality rose most. Indeed we do not know whether there has been any change at all in employer perceptions of workforce skill levels in the thirty-five years for which we have Current Population Survey data on wage inequality. Clearly, these studies provide important hints as to how to approach the skills mismatch question, but equally clear are the complexity of the issues and the large gaps in knowledge that remain.

DATA

This paper uses a number of well-known data sets to study trends in workers skills and job skill requirements, including the 1 percent Public Use Microdata Sets of the U.S. Census for 1960-1990, the March Annual Demographic files (1962-1997) of the Current Population Survey, and the Merged Outgoing Rotation Group (MORG) files (1979-1997) of the Current Population Survey.[4] The March files provide educational, occupational, and industrial data for the longest

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Teixeira (1998), Gale (1997), Murnane, Willett, and Levy (1995), and my own tabulations from the January 1991 supplement to the Current Population Survey.

[4] The PUMS data are from Steven Ruggles and Matthew Sobek et. al., Integrated Public Use Microdata Series: Version 2.0, Minneapolis: Historical Census Projects, University of Minnesota, 1997

time span, but the Census and MORG files have the advantage of much larger sample sizes, which will be important in examining detailed occupational categories.

Supplements to the CPS for October 1984, 1989, 1993, and 1997 contain information on computer use at work, which will be used as a measure of technology.

A dual-coded 1970 Census to which 1980 Census occupation and industry codes have been added is also used here to reconcile the coding schemes of data series constructed using the Current Population Survey.[5]

(http://www.ipums.umn.edu). The CPS MORG files were kindly provided by Daniel Feenberg of the National Bureau of Economic Research.

[5] I thank Ms. Libbie Stephenson and Prof. Donald Treiman of UCLA for kindly providing me with the dual-coded 1970 Census extract.

TRENDS IN THE SUPPLY OF AND DEMAND FOR EDUCATION AND THE ROLE OF TECHNOLOGY

Wage Inequality and Trends in the Supply of and Demand for Education

Any explanation of trends in inequality will have to be consistent with the temporal pattern of its growth. Figure 1 shows the trend in the variance of log wages for wage and salary workers for 1979-1997 using the CPS-MORG files.[6] The non-linearity of the growth is immediately evident. About 50 percent of the growth of inequality between 1979-1993 occurs in just the two years 1981-1983, coinciding with the deepest recession in U.S. history since the Depression and prior to the greatest diffusion of computers. Inequality growth then flattens out and declines somewhat in the late 1980s and early 1990s. The large growth in inequality between 1993-94 may reflect a continuation of the increase visible in 1991-92 but may well reflect changes in the CPS questionnaire design, as well. Inequality then declines modestly for the rest of the 1990s.

Figure 2 shows trends in mean years of education for all workers from the March Current Population Survey for 1962-1997.[7] The discontinuity between 1991 and 1992 in this figure is artifactual and reflects the need to impute years of education after the CPS adopted new education codes in 1992 which use categories (e.g., college degree) instead of years of education for some ranges of the data. Mean years of education after 1991 are imputed based on response patterns in 1991.

The pattern in Figure 2 is a nearly linear rise in workers' mean years of education between 1962-83, then a slowdown in growth between 1983-91, as noted in the neoclassical literature, and an even flatter trend for 1992-97. Had growth not slowed in the 1980s, average years of education would have been about 13.50 in 1991, rather than 13.07. Data from the General Social Survey, which reports years of education consistently for 1972-1998, indicate that the relatively flat trend in the 1990s is not an artifact of the imputation required by the new

[6] To avoid top-coding problems, these calculations were performed on workers in the bottom 95% of the weekly earnings distribution, who were below the top code value in all years.

CPS educational coding scheme (results not shown), a point which is significant given the arguments made below.

As noted, Katz and Murphy (1992) suggest the disequilibrium responsible for the growth in inequality may reflect the slowdown in the growth rate of the supply of more educated workers in the 1980s rather than any acceleration in demand. But a closer inspection of the evidence reveals problems with this supply side explanation. If one were to assume that supply and demand were in equilibrium prior to the 1980s and demand continued to grow at a constant rate thereafter while supply growth slowed, as Katz and Murphy argue (1992), trends in supply and demand would look something like Figure 3. The line representing supply reproduces the mean education series from Figure 2, while the trend line for demand simply extrapolates from growth rates in supply for 1974-1979. As can be seen, if demand continued to grow at a constant rate in the 1980s then a skill gap emerges, as neoclassical explanations of rising inequality predict.

The only problem is that the timing of the emergence and widening of the skills gap is inconsistent with the temporal pattern of inequality growth. From Figure 3, the skills gap is either not present or minor in the early 1980s and grows more severe as time progresses, reaching its widest point in 1997. Yet inequality grew most rapidly in the early 1980s, moderated steadily as the decade progressed, and does not seem to have grown much at all in the 1990s, despite the flat trend in workforce education levels. The timing of inequality does not correspond to the deceleration in the growth of workers' educational attainment.

Indeed, the problem for the neoclassical explanation is actually a bit more serious than Figure 3 suggests, since it is well known that there was an oversupply of educated labor in the 1970s, so the demand line actually should be drawn below the supply line in that decade, which would mean the skill gap did not begin to "bite" until even later than shown, depending on how far down one shifts the demand line relative to supply in the 1970s. The only way to derive a skills deficit in the early 1980s following the skills glut of the late 1970s is to assume significant acceleration in the growth of demand for skill, as Mishel et al. (1997) have argued is implicit in the skill-biased technological change argument. Whether technology can reasonably be argued to

[7] Data on education are missing from the 1963 March CPS file.

have had a stronger effect in the early 1980s relative to previous decades will be considered in subsequent sections.

Before examining this question it is worthwhile to examine trends in the inequality of educational attainment, as well as the mean. Figure 4 indicates that inequality in attainment declined from 1962-87, albeit at a gently decelerating rate, before flattening out. Assuming a standard wage equation in which *b* is coefficient on education, since

$$variance\ ln\ (wages) = b^2 * variance\ (years\ of\ education)$$

holding all else constant, greater equality of educational attainment or the supply of skills implies, ceteris paribus, a more equal distribution of wages.[8] Though the returns to education were not constant over time, their rise exerted an offsetting disequalizing effect, it is important to recognize that changes in the distribution of education exerted an equalizing effect until relatively recently. It is not the case that changes in the distribution of human capital as measured by education have contributed to inequality growth.

The Relationship Between Education and Computer Use

The skills shortage thesis relies heavily on the notion that computers have increased the demand for educated labor. As a first cut to examine this question one can regress years of education on computer usage, controlling for relevant background characteristics. This approach has clear weaknesses, discussed below, but the results are instructive as a first approximation.

Table 1 presents the results of regressions of years of education on a dummy for computer usage (Models 1 and 3) and augmented with dummies for a number of specific computer tasks (Models 2 and 4). All models include controls for membership in seven age groups, female, black, part-time status, marital status and its interaction with female, region, and

[8] Figures for years prior to 1992 may be affected by the growing number in the top-coded category 18+ years of education and some might argue that years of post-secondary education should be weighted more heavily in calculating educational inequality. However, neither truncating the distribution below the top code for all years nor

three-digit industry. Models in the lower panel add controls for one-digit occupation. The data are the October CPS supplements for 1984, 1989, 1993, and 1997.

Model 1 indicates that computer use is associated with a little over one year of education and the association increases somewhat over time, though the most rapid increase occurs between 1993-97, when wage inequality was declining. However, once one controls for one-digit occupation these estimates are cut in half (Model 3). While in theory there may be an argument that occupation is endogenous to knowledge of computer skills, it is doubtful that differences in membership in such gross occupational categories owes much to temporally prior differences in computer skills. In all probability the lower estimates in Model 3 are more reasonable.

Even so, causal interpretation of these models is not straightforward. The preponderance of the association between education and computer use is observed as early as 1984. Since computers became common not long before 1984, it is not clear that the magnitude of the association already visible in that year reflects employers' hiring practices. In normal periods one would not expect ordinary turnover to generate so many vacancies that mean education levels would be affected to the degree observed even if employers did raise hiring standards and it is unlikely that employers would have engaged in mass layoffs simply to accomplish this end. Yet the early 1980s were not normal times and it is possible that layoffs during the recession and new hiring during the recovery resulted in the educational upgrading of many jobs, though the groups most at risk for layoff, such as blue collar workers, were least likely to have computers introduced on their jobs. It is possible that the distribution of computers by education did not reflect a resorting of workers but employers' judgments as to who was capable of using the new equipment, in which case the observed association could reflect a causal relationship. But it is also possible that computers were given initially to more educated workers because they were already employed in positions that could most benefit from them or because the establishments which could afford computers could afford to employ more educated workers as well. In either case, the association would not reflect some additional

giving years of post-secondary education an arbitrarily higher weight of 1.25 alters trends in educational inequality for all workers much at all.

increment of skill which the presence of computers introduced into the workplace or would be an upwardly biased estimate of any such effect.

The long-term trend in the computer coefficient over time may be seen as stronger evidence in favor of a causal relationship, since it may be interpreted as reflecting the effects of turnover and increased hiring standards, even if the level of the coefficient for 1984 is acknowledged to be biased upward. Of course, the magnitude of the growth in the coefficients, even if it does reflect technology-induced resorting of workers, is much smaller than the coefficient levels themselves, mostly about .08 years of education. And the increasing association between education and computer use may not simply reflect the resorting of workers. Given the increasingly wide diffusion of computers, it may be that not using a computer at work is simply an increasingly better indicator of a very low status job. It is also important to note that the observed association of computer use with education continues to rise in the late 1980s-90s even when wage inequality does not.

There is also the issue of interpreting the magnitude of the association even assuming a causal relationship for the coefficient levels. If one accepts that a worker who uses a computer must have an additional one-half to one year of education compared to an otherwise similar worker, this implies about a 3-8% premium for computer use operating through enhanced education requirements alone, not counting any direct effect through computer-specific human capital. The low end of this range, which is the more probable, does not seem likely to be large enough to account for much of the observed growth in inequality, but if one accepts the high end and adds some large wage effect for computer use itself (e.g. Krueger 1993), then the situation is less clear.

Despite the problems in determining causality or judging magnitudes, it is useful to note that even by relatively generous estimates the educational upgrading effect of computers is not likely to exceed one year of education, which at least provides an upper bound and a caution for those who would see computers as dramatically upgrading the educational requirements of work. Even in the most favorable case, computers are not typically leading to the replacement of high school educated workers with college educated workers or even workers with a junior college education.

Models 2 and 4 add dummies for specific computer tasks to Models 1 and 3 for 1989, 1993, and 1997.[9] Coefficients for spreadsheet use and word processing are the most consistently large, averaging about .4 years and .2 years each in Models 2 and 4 respectively. Some coefficients are clearly biased. It seems unlikely that the skills required to use e-mail require .4 years of education (Model 2, 1997) or that programming requires less skill than either e-mail or word processing. Whether the use of computers for inventory and invoice work actually deskills these tasks, as suggested by the negative coefficients, is also open to question. More likely they simply pick up otherwise unmeasured variation in occupational status. In short, while some of the results for specific computer tasks may be plausible, quite a few are not.

As a final way to investigate the effect of computer use on educational requirements, Table 2 presents results of fixed effects estimates of the effect of changes in computer use rates within three-digit occupations on the educational composition of the occupation, measured both in years of education and percentage within different educational categories. The table presents results for three periods, 1984-89, 1993-97, and 1984-97. The first two periods have the advantage of consistent educational codes, while the third spans a longer period, ensuring more variation in the dependent variable, even though the change in coding scheme introduces measurement error as well. For each period two models are estimated, the first a constant-only model to obtain a baseline measure of the time trend and the second adds a variable measuring changes in computer use. More formally, this model can be written as

$$\Delta Ed_i = \alpha + \beta * \Delta C_i + \varepsilon_i,$$

where

ΔEd_i = average annual change in mean years education within occupation *i* or annual change in percentage share of an education group (e.g. high school grads) within occupation *i*

[9] Data on specific computer tasks is unavailable for 1984.

ΔC_i = average annual change in the percentage of computer users within occupation *i*

ε_i = error term

This fixed effect model controls for unobserved, time-invariant characteristics of occupations which might be correlated with both education and computer use, which might bias coefficients in Table 1. These models are similar to those in Autor (1995) and Autor et al. (1998), except that those models estimate educational upgrading within industries without controlling for changes in occupation composition. As will be discussed further below, it is not surprising that they find strong computer effects, but the causal status of the observed association is questionable because of the strong possibility that both computer use and education levels within industries share a common dependence on exogenous changes in the occupational composition of employment within industries. Using occupation as the unit of analysis controls for this possibility.

The results in Table 2 give mixed support for the computer-educational upgrading thesis. The first row of models uses years of education as the dependent variable. Model 1 for 1984-89 indicates that mean years of education within occupations grew at an average annual rate of .017 years. Model 2 adds computer use and indicates that a percentage point increase in computer use is associated with an increase in mean education of .002 years, a bit more than 10% of the size of the unconditional time trend. A 12 percentage point increase in computer use, about average for the period, is associated with an increase of .024 years in an occupation's mean education level during this period, well below the actual mean education increase of .18 years using individual-level data. Another way to look at this coefficient is that an occupation which moves from having no computer users to 100% computer users is predicted to increase mean education by .2 years, well below even the lower bound estimates in Table 1. Computers are not associated with increased education for 1993-97 and seem to be associated with <u>decreased</u> education levels for the full period from 1984-97. However, once one controls for an occupation's preexisting educational level, following Autor et al. (1997), the coefficient for 1984-97 turns positive again (Model 3).[10]

The remaining rows use categorical measures of the educational composition of occupations, using as dependent variables the percentage of workers who have less than high school, high school, some college, a B.A., and post-graduate education within occupations. Changes in computer use do not predict changes in the share of less than high school educated workers within occupations and where computers predict employment shares of those with a post-graduate education the coefficient is inappropriately signed. The results for high school and college-educated workers seem more robust than those for workers with some college only. Results from Model 3 for 1984-97 suggest that a 25 percentage point increase in computer use within occupations, about average for the period, was associated with a 2.7 percentage point decline in the share of high school educated workers and a 1.1 percentage point increase in college-educated workers within an occupation. By comparison, using the raw microdata, the share of high school educated workers declined by 6.7 percentage points and the share of college-educated workers increased 5.3 percentage points in this period. These results suggest that increased computer use is associated with increasing educational requirements, though after deleting influential cases the coefficient for college educated workers drops to about 0.003, implying that a unit increase in computer use is associated with only a 0.07 percentage point increase in the percentage of college educated workers within an occupation.

However, a further test of the robustness of the results in Table 2 casts doubt on a causal interpretation of the association between changes in computer use and educational levels within occupations. The first column of Table 3 repeats the significant results from Table 2, while the second column uses the computer use data for 1984-97 to predict changes in educational levels within occupations for 1971-76 using the same model.[11] The results are remarkably similar. A logical interpretation is that changes in computer use serve as an indicator of occupations that

[10] The additional control is for education within the occupation in 1970, calculated from the dual-coded 1970 Census extract.

[11] Since the October CPS files for 1984 and 1997 use 1980s occupation codes, changes in the rates of computer use within 1970s occupation codes were derived by merging the 1980s occupation-level change rates onto the individual-level in the dual-coded 1970s Census extract and then calculating mean change rates by 1970s

were upgrading their education levels in both the 1980s-90s and the early 1970s, before computers played much of a role in the workplace. This suggests that while changes in computer use are associated with skill upgrading the relationship is quite likely not causal. The same occupations which were upgrading in the 1980s-90s coincident with the rapid adoption of computers were upgrading long before then. Autor et al. (1998, 1194) report similar results using their industry-level models.

Finally, before leaving the subject of educational upgrading within occupations, it is useful to consider trends for blue collar manufacturing workers. Some suggest that factory automation and the introduction of shopfloor participation in quality control and decision making leads to greater use of college educated workers in production jobs (e.g. Zuboff 1988). Table 4 presents trends in the percentage of all workers and blue collar manufacturing workers who have no more than a high school education, some college, and at least four years of college. The choice of years reflects changes in occupation and education codes, as well as decadal transitions. The table shows that while it is true that the share of less educated workers has declined among blue collar manufacturing workers, the rate of decline has consistently trailed that of the workforce as a whole and shows no acceleration in the 1980s relative to the 1970s (Table 4, right panel). The figures for the 1990s do suggest acceleration, though this does not coincide with any growth in overall inequality and possible effects from the educational coding changes complicates comparisons with earlier periods. As the bottom line of the left panel indicates, despite occasional anecdotal evidence to the contrary, college grads continue to comprise a very small share of production workers in manufacturing.

TRENDS IN THE OCCUPATIONAL DISTRIBUTION

Trends in Major Occupational Groups' Shares of the Workforce

occupation code using the relative number of individuals with different 1980s codes within each 1970s occupation as a method of self-weighting.

Although education is the principal measure of skill within economics, within sociology occupation has been another commonly used indicator of job skill level. Unlike personal educational attainment, most sociologists would consider occupation to be a better measure of the nature of jobs rather than of those filling them. While relatively detailed occupational groups cannot be ordered without measures from the *Dictionary of Occupational Titles* or similar sources, aggregated occupational categories offer an intuitive, if rather gross, measure of skill. Indeed, Berman et al. (1994) use even more aggregated categories, the production/non-production worker dichotomy, to measure skill trends within manufacturing. Fortunately, Census and CPS data permit a more disaggregated approach. In addition, these data permit examination of trends for specific detailed occupations that are likely to be most affected by technological change.

The questions to be explored below are whether there is evidence of occupational upgrading and, more importantly, whether any such trend accelerated over the course of the 1980s in a fashion that might explain inequality growth and suggest a role for technology.

In general, the results do not suggest acceleration of demand shifts throughout most of the 1980s-90s, but there is a sharp decline in the share of blue collar workers in manufacturing in the early 1980s when inequality rose sharply. On the question of whether occupational trends can be related directly to measures of technology, the evidence to support this thesis turns out be much less strong than proponents claim.

It is useful to begin with a long view. Figures 5-7 present trends in the share of the workforce belonging to six highly aggregated occupational groups for 1900-1990 based on published tabulations. Despite changes in occupational codes, there is probably a reasonable degree of comparability across decades at this level of aggregation. The figures for 1970 use published Census tabulations from a 1970 Census extract recoded in terms of 1980 occupational codes.[12]

[12] The Census bureau recoded extracts from 1950, 1960, and 1970 in terms of the subsequent Census occupational categories and most figures are little affected by the coding changes. Even the significant changes in occupational coding between 1970-1980 affect the shares of these occupational aggregates by at most 1-2 percentage points. Since less certainty is possible for earlier years, the figures should be interpreted more cautiously. Data for these conclusions and for Figures 5-7 are drawn from published Census tabulations in Kaplan and Casey (1958), U.S. Bureau of the Census (1976), U.S. Bureau of the Census (1973), U.S. Bureau of the Census (1983), and U.S. Bureau of the Census (1993).

Figure 5 shows that the share of the highest skill group, upper white collar workers (managers, professionals, technical workers) not only grew substantially from 10% (1900) to 30% (1990) of the workforce but that this increase accelerated over time, with fastest growth between 1970-1990. However, there is no difference in the growth rate between the 1970s and 1980s nor does CPS data, presented below, indicate any change in the 1990s. In short, there would seem to be little about demand for upper white collar workers in the 1980s that would make it distinctive from adjacent decades such that it might explain the growth in inequality, though the continued increase in the upper white collar share when their relative wages were presumably rising may be evidence for an acceleration in underlying demand.

Figure 5 also shows that the share of lower white collar workers (sales, clerical) rose continuously throughout the century from 7.5% to roughly 28% of the workforce, but essentially stopped growing between 1970-1990. However, if the original 1970s occupational codes are used for 1970, the slowdown is restricted to the 1980s (results not shown). Whether computers played a role in this development will be investigated below.

Figure 6 shows that the share of craft workers has not changed much during the century, fluctuating between roughly 11-14%, though there is a modest decline, without acceleration, between 1970-1990. However, the share of lower blue collar workers (operatives, transport operators, laborers) has declined consistently and markedly in the post-war period from a high of roughly 28% (1940) to its lowest level this century, less than 15% (1990), though again the 1980s do not look very different from the 1970s in this respect. Still there is the question, addressed below, as to whether the constancy of the decline in the face of possible relative wage declines should be actually be seen as an acceleration in the demand shift away from this group of workers.

Figure 6 also shows that the share of workers in low skill service occupations has grown modestly from about 9% (1900) to a little over 13% (1990).

By contrast, Figure 7 shows that the share of workers in farm occupations fell from 37.5% to 2.5%, by far the largest change of any of the groups examined here. While little noticed in the long-running sociological debate on skills, clearly, skill trends over the course of the twentieth century depend more on the decline in agriculture and how one evaluates the skill level of declining farm occupations than on any other single trend (cf. Braverman 1974, p.381; Spenner 1983, p.825). However, the change in the share of farm occupations has been slight since 1965 and will not be discussed further.

Summarizing the figures for the non-agricultural workforce and making allowance for the difficulty of rank ordering lower white collar workers with respect to craft and lower blue collar workers, one can say with reasonable confidence that the trend has been one of general upgrading, but that skill trends in the 1980s do not appear upon initial inspection to have accelerated, in marked contrast to trends in wage inequality.

It is worthwhile to look at figures similar to the Census series using the CPS because they extend the figures beyond 1990 and because they provide a finer-grained picture of the temporal patterning of change. Figure 8 presents trends from the March CPS for 1962-1997. Changes in the occupational coding schemes create some discontinuities between 1970-1971 and 1982-1983. The most notable differences are the series for lower white collar (not shown) and, even more so, lower blue collar workers. While the Census figures for 1980-1990 suggest a very modest increase in the share of lower white collar workers, the longer CPS series clearly suggests a decline between 1983-1997 of a bit more than 1% and the diffusion of computer technology is a plausible candidate for this decline.

The details of the lower blue collar series are even more striking. Unlike the decadal Census figures, the annual CPS series indicates that almost all of the decline in the lower blue collar share occurred prior to 1985. Between 1965 and 1985 the share of lower blue collar workers declined by an average .42% per year, while the rate for 1985-1997 was .11% per year (not shown). The flatness of the latter trend does not reflect manufacturing's declining overall share of the workforce. Within manufacturing, the contrast between the corresponding figures are even more stark, .52% and .05% (not shown), even though it is here that one might expect technology to have the greatest effect (see Figure 9). Within-industry shifts are often used as measures of technological change. However, as Howell (1994) observed with reference to the less recent series in Berman et al. (1994) and as Figure 9 shows, the steep decline in the share of blue collar workers within manufacturing virtually halted by 1985. If automation and computercontrolled processes were making blue collar workers redundant in unprecedented numbers, there is no evidence for it in these figures.

Some have raised the possibility that the relative stability of the blue collar share within manufacturing reflects the decline in their relative wages which makes them relatively more attractive than when they were better paid (Eli Berman, personal communication). If the share of blue collar employment is stable in the face of declining relative wages, then presumably underlying demand for these workers is still falling. Figures 10 and 11 plot the blue collar share of employment within manufacturing against the ratio of blue collar and non-blue collar average wages and using the CPS March and ORG series respectively. Figure 10 uses the ratio of weekly wages and Figure 11 uses hourly wages.[13] Figure 10 indicates that relative wages of lower blue collar workers declined in a roughly constant fashion since 1980, while the share of lower blue collar employment stopped falling after 1986. This pattern suggests a continued declining demand for blue collar workers after 1986 but a sharp deceleration. Figure 11 indicates relative wages stabilized after 1990 while employment stabilized after 1985, suggesting deceleration in the demand decline for 1985-90 and absolute stability for 1991-97. Despite their differences, both figures show that the very rapid decline in the demand for blue collar workers occurred during the early 1980s, prior to the widespread diffusion of computer or other advanced microelectronics. They suggest the importance of the decline of blue collar manufacturing work for inequality growth, long emphasized by Bluestone and Harrison (1983; Harrison and Bluestone 1988), rather than the emergence of an information economy. The timing of blue collar manufacturing decline points to the effects of the recession and trade deficits, rather than an upsurge in factory automation and consequent labor displacement.

Following Berman et al. (1994), one might investigate the relationship between trends in the occupational composition of the workforce and technology diffusion by estimating models similar to those in Table 2 using industry as the unit of analysis in the form:

$$\Delta Occ_i = \alpha + \beta * \Delta C_i + \varepsilon_i,$$

where

[13] Figures in both graphs are weighted by hours as well as sample weights, but consistent measures of usual hours worked are available in the March series only as far back as the 1976 survey year.

ΔOcc_i = average annual change in percentage share of an occupation group (e.g. managers and professional) within industry *i*

ΔC_i = average annual change in the percentage of computer users within industry *i*

ε_i = error term

Table 5 estimates five such equations for different occupational groups for all industries for different time periods between 1984-1997 for which computer data are available. These models are similar to those estimated in Berman et al (1994), which regress the non-production worker share on computer usage within manufacturing industries. Table 6 estimates the same equations as Table 5 but restricts the sample to manufacturing industries to be comparable to Berman et al. (1994). To conserve space, only models with significant results are reported in Table 6.

As can be seen from Table 5, there is some evidence that the share of upper white collar workers is positively related to the percentage of computer users within an industry, particularly in the early part of the period covered. Similarly, there is some evidence that the share of craft and lower blue collar workers is negatively related to the number of computer users within an industry. Rather surprisingly, there is no significant relationship between computer use and the share of clerical workers within industries, though the computer coefficient for 1984-97 implies about a 2 percentage point decline in the share of clerical workers and the p-value (.103) is just above conventional levels of significance.

Table 6 indicates a somewhat stronger relationship between computer use and occupational upgrading within manufacturing industries, consistent with Berman et al. (1994). None of the computer coefficients in models using the percentage of clerical workers as the dependent variable were significant and they are not reported in Table 6.

Results in Tables 5 and 6 suggest at least some support for the idea that computers are upgrading the occupational structure. However, there is a problem with the theory underlying these models and those in Berman et al. (1994) from which they derive. While it may be the case that an exogenous increase in computer use within industries increases demand for upper white collar workers, it is also almost certainly the case that an exogenous increase in the relative employment of managers and professionals will lead to an increased share of the workforce using computers. Descriptive statistics from the October 1989 CPS, for instance, show that managers, professionals, and clerical workers have by far the highest rates of computer use (e.g., 60-67%), while blue collar workers have among the lowest rates (9-17%), when the overall percentage of computer users was about 37%. Computers were becoming a standard piece of office equipment in the 1980s and it is hard to see that any decision to add to the upper white collar work force would fail to be accompanied by additions to the stock of computers, as well as desks and office chairs.

To see the difficulty with the Berman et al. (1994) kind of models more concretely, Table 7 reestimates the models in Table 6 except that the percentage of computer users is now the dependent variable and the share of upper white collar, craft, and lower blue collar workers are independent variables. Not surprisingly, one finds that for 1984-97 a one percentage point increase in the upper white collar share of employment is associated with a one percentage point increase in the share of computer users within an industry, while increases in the shares of the other two groups are more weakly associated with decreases in the share of users. Instead of modeling the demand for different kinds of labor as a function of the stock of office equipment, one can just as easily use the same variables to model demand for computers as a function of employment patterns by occupation. One might reasonably ask what might have led to the increased demand for upper white collar workers in the 1980s other than the diffusion of computers—were it not for the fact that this group's share of employment has grown throughout this century.

Clearly, the strong probability of two-way causation severely limits the kinds of conclusions one can draw from this kind of exercise. This problem is also present in the models estimated in Autor et al (1998), which regress trends in the percentage of different educational groups within industries on changes in the share of computer users without controlling for occupational changes. Any association between educational levels within industries and computer usage might reflect their common dependence on exogenous changes in the occupational composition of employment.

Trends in the Growth of Occupations Potentially Sensitive to Technological Change

Trends in the composition of employment by aggregated occupational group give some indication of the direction and pace of skill shifts and some suggestions as to whether technology is playing a role. The case of blue collar manufacturing workers described above, for instance, does not suggest that factory automation has displaced large numbers of less skilled workers. However, the use of broad occupational groups is limiting and even regression models are not always helpful, as seen above. One can examine the possible effects of technological change on the occupational distribution in a more detailed fashion using selected three-digit occupations which one might suspect à priori to be especially sensitive technological change.

Table 8 presents trends in different detailed occupations' share of the workforce and certain industries (left panel) and the annual percentage point increase of that occupation (right panel) for 1971-97 using the March CPS. The choice of specific years in the left panel reflects the change in occupational coding schemes between 1982 and 1983, which fortunately is not a large problem in many cases here , and the desirability of isolating changes in the early 1980s, which was a period of abrupt change in wage inequality, as noted earlier. All figures are weighted by hours worked as well as CPS sample weights. All figures for the years shown have been checked against plots for the entire period to insure that conclusions are not substantively affected by choice of period endpoints

As noted earlier, technology can alter the demand for skill by either adding workers at the top of the occupational skill hierarchy or eliminating them at the bottom as a result of automation, for instance, as well as altering the skill content within occupations.

The first two rows of Table 8 present trends for scientists/engineers and technicians. If information technology were increasing the skill requirements of work by adding workers at the top, one would expect the shares of these workers to rise and if such growth were to be related to inequality growth in the 1980s one would expect acceleration in that decade. However, the data indicate that while the shares of workers in these two groups grew steadily since the early 1970s, their absolute shares remain relatively small and their growth accelerated only modestly in the 1980s-1990s, though growth was rapid during the recessionary period of the early 1980s. Scientists and engineers grew at a rate of 0.05% per year since 1983 and technicians grew only 0.02% per year. Despite much talk of the growth of knowledge workers, most upper white collar workers are not in highly technical occupations and growth rates remain relatively low.

Similarly, the third and fourth rows indicate that despite the visible and dramatic growth of the importance of computers in the economy, computer systems analysts/scientists and programmers represented less than 2% of the workforce as recently as 1997. While the growth of systems analysts and computer scientists did accelerate in the late 1980s, they remain a small group and the share of programmers, surprisingly, does not even seem to have accelerated for most of the period covered here.[14]

The first four rows of Table 8 represent high skilled occupations which might be expected to expand with the growth in high technology. Clearly, the growth of these occupations has been rather steady over time, rather than accelerating dramatically in the 1980s. The remaining rows of Table 8 represent occupations which many have argued are being eliminated by the impressive spread of computer and microelectronic technology, most of them less skilled. Danziger and Gottschalk (1996, p.141) express the conventional wisdom:

> [Beginning in the 1980s f]irms substituted computers and more-skilled workers for lower-skilled workers whose tasks could now be performed more efficiently with computers. Insurance companies could lay off file clerks…checkout clerks no longer had to enter prices in the cash register. Inventory control was simplified and reordering could be done automatically. In these and other ways, technology (or automation) decreased the value of the skills of workers with lower levels of education and increased demand for workers with more education.

In this passage, Danziger and Gottschalk explicitly link the labor-displacing effect of computers to the growth of wage inequality. The examples they cite and others which they do not mention, such as bank tellers, have much common sense appeal. However, trends in these occupations have rarely been examined systematically.

[14] Although the computer equipment <u>industry</u> employs workers of all skill levels, it is worthwhile to note that this industry never accounted as much as 1% of total employment. Between 1971-1985, the computer hardware industry share of employment rose from 0.27% to 0.85%, before falling to 0.57% in 1997.

The fifth row of Table 8 presents trends in the percentage of grocery store workers who are cashiers, the checkout clerks Danziger and Gottschalk cited who are most likely to use scanners rather than manually entering prices into cash registers. The table indicates that cashiers grew as a percentage of grocery store workers in the 1970s, then declined very modestly after 1983, consistent with the scanner story. A plot of the full series indicates that the trend was flat for 1983-91 and the decline somewhat uneven afterward (not shown). At best, one can say that scanners might have stopped the growth in the cashier share evident in the 1970s, but there seems to be very little actual decline even after nearly two decades during which scanners diffused. This is not to say that scanners have necessarily had no effect on productivity, either by speeding customer throughput or generating more readily used information for inventory and planning databases. It is merely to say that there has been little decline in employment as a result, though growth has clearly halted.[15]

Danziger and Gottschalk also refer to the computerization of inventory control, which presumably reduces the need for various kinds of clerks to keep track of stock. However, Table 8 indicates that the share of shipping, stock, and inventory clerks in retail and wholesale declined more rapidly in the 1970s than in the 1980s-90s.[16] Combined with the results for cashiers, these results do not suggest that highly visible computer and microelectronic technologies have had much labor displacing effect in retail.

The next section of Table 8 deals with clerical workers. As a share of all workers, clerical workers as a group grew during the 1970s and declined steadily after 1983. This series is rather strong evidence that the century-long increase in the clerical employment share has ended, though plots indicate the most dramatic declines were in 1986-89 and especially 1992-97, after the large increase in inequality. The ratio of managers and professionals to clerical workers, a measure of "clerical productivity" since most clerical workers support the work of managers and professionals, also increases sharply during 1992-97, though less dramatic increases are evident as early as the 1970s. In the absence of more detailed information it is unclear whether to

[15] Average sample size for grocery stores is 1,460. It should be said that Census figures for 1980 and 1990 do suggest a decline in the share of cashiers within grocery stores, from about 30% to about 26%, though this is still well above the level in 1970 (20%).

[16] Average sample size for wholesale and retail industries in the March CPS is 12,302.

ascribe this growth in the upper white collar/clerical ratio to technology or to more general cost-cutting policies on the part of employers, particularly given the insignificant relationship between computer use and percentage of clerical workers within industries in Table 4. Even so, the sharp growth in the ratio in the 1990s is at least consistent with a role for computer technology in reducing demand for this kind of work, but the development does not coincide with the period of inequality growth.

A stronger case for the possible impacts of information technology on clerical employment is the trend in clerical workers as a percentage of workers in banking and insurance. Clerical tasks in these industries are highly repetitive and routinized and banking and finance have long been leaders in adopting computer applications for office automation. After remaining steady as a share of industry employment in the 1970s, the clerical share in banking and insurance falls more sharply than any other occupation in the table and the plot in Figure 12 shows that the decline was consistent throughout the 1980s-90s.[17] Danziger and Gottschalk's hypothesis that computers have automated the work of file clerks in this sector seems well supported. This occupational group clearly shows the pattern one would expect if information technology were driving skill demand shifts through changes in the occupational composition of employment. Unfortunately for the skill-biased technological change thesis, it is one of the few occupational group to show such a clean pattern.

The share of secretaries as a percentage of all workers begins to decline around 1983 and falls consistently thereafter. Similarly, the ratio of managers and professionals to secretaries is flat for the 1970s, rises significantly between 1983-91, and then accelerates dramatically after 1992. There is some question as to whether the decline in the secretarial share is real or an artifact of changing response patterns that have resulted in more of these workers being assigned to the residual "clerical workers, not elsewhere classified" category, perhaps because computers have led to the bundling of new tasks and more responsibility into such jobs that the old title no longer seems to fit in many cases (Autor 1995). Given the overall decline in the share of clerical workers it is not clear whether this is a reasonable supposition, but in any case, even if one

[17] Average sample size for banking and insurance in the March CPS is 2,787.

accepts the relative decline of secretaries as genuine the timing is not consistent with the pattern of inequality growth.

The next row of Table 8 gives trends in the share of tellers as a percentage of all workers in banking. The rapid spread of automated teller machines (ATM) would seem to make this occupation an ideal candidate for obsolescence. In fact, the results in Table and a plot in Figure 13 show no such strong trend, but rather at best a one-time drop in the teller share in the early 1980s. There is some modest growth in the teller share during the 1970s, a large drop between 1982-83 which may reflect either genuine change or occupational coding changes, and a rather modest decline over the next 14 years.[18] Decennial Census data for 1980 and 1990, which are less subject to the changes in coding than the CPS, as well as the dual-coded 1970 Census extract suggest that the observed decline between 1982-83 may be genuine rather than an artifact of the changes in occupational coding. If so, this suggests that the share of tellers within banking declined from about 23% to about 18%, mostly within the space of a single year in the early 1980s. The timing of the decline coincides with both the recession and the growth of inequality, but the flatness of the trend for most of the 1980s-90s casts some doubt on a technology explanation. While it is possible that ATMs had the kind of abrupt impact observed in Figure 13, this trendline, unlike that for all clerical workers within banking and insurance, does not correspond to intuition about the effects of automation on the composition of employment. If anyone expects ATMs to have rendered the teller occupation obsolete there is certainly no evidence of it in Figure 13. This finding is consistent with sector studies of tellers within banking (Larry Hunter, personal communication).

Like banking and insurance, back office work in the U.S. postal service is a large-scale, highly standardized, high volume operation. In principle, this makes postal operations ideal for automation on a large scale in areas such as letter sorting. Nevertheless, rather surprisingly, Table 8 indicates that postal clerks have not declined much as a share of all postal workers in the last 25 years.[19] Further, the 1980s-1990s do not seem to differ from the 1970s in this regard.

[18] Average sample size for banking in the March CPS is 1,075.
[19] Average sample size for the postal industry in the March CPS is 489.

The telephone industry has substituted electrical and electronic equipment for labor in a highly visible fashion for at least a century. Indeed, the transistor was invented by Bell Labs so it is not surprising that microelectronics have replaced switchboard operators and other workers over time. Indeed, Table 8 indicates that operators declined from over 21% of all telephone workers to less than 4% between 1971-97.[20] What is interesting is that the rate of decline was faster in the 1970s than in the 1980s-90s.

Telephone installers and repairers also comprise a substantial fraction of all employment in the industry and have likely been affected by improvements in telephone switching equipment. The share of these workers has declined by nearly half, from 32% (1971) to 17.5% (1997). The rate of decline for this group did accelerate in the mid 1980s-1990s relative to the 1970s when calculated on the basis of the years shown in Table 8. However, a plot of the full series, along with the MORG CPS series and the 1960-90 Census figures casts some doubt on this result.

Finally, Table 8 provides trends for the percentage of workers in the auto industry who are assemblers and welders/painters. The use of industrial robots is widely recognized to be most advanced in the auto industry and welders and painters are believed to be most strongly affected. Figures for assemblers are presented for comparative purposes, since automation efforts are widely recognized to have failed in auto assembly (John Paul MacDuffie, personal communication). Rather surprisingly, although the shares of both groups declined for a few years in the early 1980s, their shares have <u>increased</u> somewhat since then.[21] Of course, there may be tendencies toward both labor displacement due to robots among large firms and increased outsourcing to more labor intensive subcontractors which offset one another. Nevertheless, there seems to be no overall effect of robots or automation on the employment of either assemblers or welders/painters in autos using either the March or MORG series. Decennial Census data does suggest a modest decline in the share of welders and painters in the auto industry, but there is little difference between the rates of decline between 1970-80 and 1980-90.

[20] Average sample size for the telephone industry in the March CPS is 682.
[21] Average sample size for the auto industry in the March CPS is 650.

It should be noted that most of the preceding has dealt with office jobs, many of which are predominantly female. Indeed, computers are primarily an office, rather than a factory, technology and might be expected to have less impact among men in the lower part of the occupational structure even though it is this group that has experienced the most severe wage losses in the last two decades. This may be another clue that technology is less important than commonly believed.

CONCLUSION

Sociologists in the 1970s and 1980s debated whether a general degradation of job quality due to deskilling was leading to a more polarized income distribution or whether a general upgrading of job content was bringing ever more people into the new middle class of knowledge workers in an information society. As it happens, economists today debate whether the general upgrading of job skill requirements has itself increased wage inequality by creating an imbalance or mismatch between growth in the demand for and supply of skills, a possibility neither side in the earlier debate contemplated.

Did post-industrialism kill the affluent society? The results presented above suggest that other factors were more likely at work. The timing of the deceleration in the growth of the supply of more educated workers does not correspond to the timing of inequality growth, which was heavily concentrated in the recession years of the early 1980s. The flatness of both the supply of educated workers and wage inequality in the 1990s casts further doubt on the supply deceleration hypothesis. On the demand side, computer use does seem to be associated with more education even controlling for occupation, but causality is uncertain and interpreting magnitudes of the observed association is clouded. Trends in occupational composition do not suggest that upgrading has been particularly rapid in the 1980s and 1990s relative to the 1970s, except for the dramatic decline of less skilled blue collar workers, particularly in manufacturing, during the recession of the early 1980s. While clerical workers lost ground during the 1980s and 1990s and computer technology is a plausible reason, there is little evidence of other technology-driven between-occupation shifts either adding jobs at the top of the skill hierarchy or automating them away at the bottom, and even the trend for clerical workers does not correspond well to the trend in wage inequality.

The general pattern of inequality growth and the specific trend in blue collar manufacturing employment suggest a closer look is needed at the role of both macroeconomic forces and the decline of institutional protections, such as primary labor markets, in explaining the growth of U.S. wage inequality.

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Table 1. Regression Coefficients of the Association of Computer Use and Years of Education

	YEAR			
	1984	1989	1993	1997
Without Occupation				
1) Computer use	1.078 **	1.162 **	1.233 **	1.358 **
R^2	0.293	0.290	0.288	0.298
N	57,492	58,378	55,622	48,960
2) *Joint Model*				
Computer use		0.938 **	0.997 **	0.924 **
Word Processing		0.261 **	0.486 **	0.495 **
Email		0.130 **	0.280 **	0.412 **
Computer-aided design		0.159 **	0.253 **	n.a.
Programming		0.178 **	0.094 *	0.162 **
Spreadsheet		0.585 **	0.496 **	0.261 **
Database		0.283 **	0.096 **	0.220 **
Inventory		-0.317 **	-0.344 **	-0.332 **
Invoice		-0.341 **	-0.363 **	-0.244 **
Sales		0.164 **	0.092 *	0.149 **
R^2		0.300	0.305	0.319
N		58,290	55,530	48,960
Occupation controls				
3) Computer use	0.505 **	0.580 **	0.664 **	0.710 **
R^2	0.438	0.429	0.411	0.406
N	57,492	58,378	55,622	48,960
4) *Joint Model*				
Computer use		0.483 **	0.545 **	0.508 **
Word Processing		0.188 **	0.331 **	0.287 **
Email		0.068	0.175 **	0.236 **
Computer-aided design		-0.142 **	-0.080	n.a.
Programming		-0.001	-0.050	-0.013
Spreadsheet		0.353 **	0.303 **	0.124 **
Database		0.206 **	0.094 **	0.168 **
Inventory		-0.211 **	-0.186 **	-0.189 **
Invoice		-0.207 **	-0.224 **	-0.128 **
Sales		0.090 *	0.038	0.070 *
R^2		0.432	0.417	0.413
N		58,290	55,530	48,960

Note: Dependent variable is years of education. Values are imputed for 1993 and 1997. Control variables in all models are seven age dummies, female, black, part-time status, marital status and its interaction with female, region, and dummies for three-digit industry. Models in the lower panel add controls for one-digit occupation. Detailed computer task items not asked in 1984. Computer-aided design item not asked in 1997. * p<.05 ** p<.01

Table 2. Regression Coefficients for the Effects of Changes in Computer Use on Changes in the Educational Composition of 3-Digit Occupations, 1984-97 (CPS)

	1984-89		1993-97		1984-97		
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 3
1. Δ *YEARS of EDUCATION*							
Δ Computer Use		0.002 *		0.001		-0.005 ***	0.002 ~
1970 Years of Ed.							-0.007 **
Constant	0.017 ***	0.012 **	0.007 *	0.006 ~	0.031 ***	0.040 ***	0.111 **
R^2	0.000	0.011	0.000	0.001	0.000	0.052	0.239
Δ *PERCENTAGE SHARES*							
<u>2. < H.S.</u>							
Δ Computer Use		0.024		-0.005		0.144 ***	-0.008
1970 <H.S. Share							-1.131 **
Constant	-0.251 ***	-0.304 ***	0.019	0.023	-0.354 ***	-0.621 ***	0.032
R^2	0.000	0.004	0.000	0.000	0.000	0.166	0.402
<u>3. H.S.</u>							
Δ Computer Use		-0.108 ***		0.001		-0.119 ***	-0.109 **
1970 H.S. Share							-1.946 **
Constant	-0.157 **	0.085	-0.350 ***	-0.351 ***	-0.431 ***	-0.212 **	0.444 **
R^2	0.000	0.047	0.000	0.000	0.000	0.065	0.353
<u>4. < B.A.</u>							
Δ Computer Use		0.058 **		0.003		-0.047 ~	-0.048
1970 <B.A. Share							0.016
Constant	0.262 ***	0.133 *	0.194 **	0.193 **	0.641 ***	0.729 ***	0.728 **
R^2	0.000	0.025	0.000	0.000	0.000	0.013	0.013
<u>5. B.A.</u>							
Δ Computer Use		0.025		-0.005		0.101 ***	0.045 **
1970 B.A. Share							1.440 **
Constant	0.105 **	0.049	0.182 ***	0.187 ***	0.300 ***	0.114 **	0.079 **
R^2	0.000	0.007	0.000	0.000	0.000	0.112	0.347
<u>6. GRAD</u>							
Δ Computer Use		0.001		0.006		-0.079 ***	-0.043 **
1970 Grad Share							-0.669 *
Constant	0.040 ~	0.037 ~	-0.045	-0.051	-0.156 ***	-0.011	-0.026
R^2	0.000	0.000	0.000	0.000	0.000	0.089	0.193

Note: Dependent variables are average annual changes in mean education and the percentage shares of different categories of educational attainment within 3-digit occupations. The independent variables are annual average change in computer use within 3-digit occupation and, for Model 3, the 1970 mean education or share of educational group within 3-digit occupation. The source for measures of the dependent variables are the 1984, 1989, 1993, and 1997 CPS-ORG files. The source for measures of computer usage are the 1984, 1989, 1993, and 1997 October CPS files. The source for the 1970 educational measures is the double-coded 1970 Census extract, which permits construction of measures for 1980s occupation codes from Census year 1970. Sample sizes are between 469-492. All models use weights equal to an occupation's average share of the workforce and robust standard errors.

~ p<.10 * p<.05 ** p<.01 *** p<.001

Table 3. Regression Coefficients for Effects of Annual Change in Percentage Using Computers between 1984-97 on Annual Change in Education Level Within 3-Digit Occupations between 1984-97 and 1971-76 (CPS)

Dependent Var.	1984-97	1971-1976
Δ EDUC. (Years)		
Constant	0.111 ***	0.096 ***
Δ Computer Use	0.002 ~	-0.002
Ed. 1970 (years)	-0.007 ***	-0.004 ***
R^2	0.239	0.096
Δ *PCT.*		
<u>High School</u>		
Constant	0.444 ***	0.689 ***
Δ Computer Use	-0.109 ***	-0.212 ***
Pct. H.S. 1970	-1.946 ***	-0.450 *
R^2	0.353	0.155
<u>B.A.</u>		
Constant	0.079 ***	0.095 ***
Δ Computer Use	0.045 **	0.056 **
Pct. B.A. 1970	1.440 ***	-0.345
R^2	0.347	0.027
<u>Grad</u>		
Constant	-0.026	0.021
Δ Computer Use	-0.043 **	0.027 *
Pct. Grad 1970	-0.669 *	0.409
R^2	0.193	0.062

Note: Figures in Column 1 are identical to those in the last column of Table 2. Column 2 applies the same model to March CPS data for 1971-76. Computer use trends for 1984-97 were assigned to occupations in that data set after using the dual-coded 1970 Census extract to obtain trends in terms of 1970s occupation codes. All models use weights equal to an occupation's average share of the workforce and robust standard errors. Sample sizes are 469 and 396.

~ p<.10 * p<.05 ** p<.01 *** p<.001

Table 4. Trends in the Percentage of All and Blue Collar Manufacturing Workers in Different Educational Groups, 1962-97 (March CPS)

	Percentage					Average Annual Percentage Change			
	1962	1971	1983	1992	1997	1962-70	1971-82	1983-1991	1992-97
HS or Less									
All	77.47	71.37	56.55	47.074	43.86	-0.571	-1.126	-0.610	-0.643
BC	95.61	94.42	88.22	81.533	78.58	-0.084	-0.441	-0.416	-0.590
Some College									
All	10.52	13.38	18.85	26.058	27.76	0.273	0.451	0.333	0.340
BC	3.64	4.91	9.50	15.516	18.08	0.077	0.319	0.352	0.513
College+									
All	12.01	15.25	24.602	26.87	28.38	0.298	0.676	0.277	0.303
BC	0.75	0.68	2.287	2.95	3.34	0.007	0.121	0.064	0.078

Note: Columns in right panel use period end points for the year prior to successive figures shown in left panel (e.g. 1970 vs. 1971). Education codes change in 1992. All cases weighted by hours as well as sample weights.

Table 5. Effects of Annual Change in Percentage Using Computers on Annual Change in the Percentage of Different Occupations within All Industries, 1984-1997 (Current Population Survey)

Dependent variable	1984-1997	1984-1989	1989-1993	1993-1997
1. Mgrs./Profs.				
Δ Computer Use	0.1182 ~	0.0964 ***	0.0725 ~	-0.0158
	(0.0681)	(0.0248)	(0.0389)	(0.0767)
Constant	0.2692 ~	0.1235 ~	0.0378	0.9679 ***
	(0.1398)	(0.0683)	(0.1062)	(0.1295)
R^2	0.0403	0.0564	0.0172	0.0003
Mean annual change	0.5252	0.3984	0.3145	0.8943
2. Sales				
Δ Computer Use	0.0254	-0.0168	0.0048	0.0367
	(0.0191)	(0.0216)	(0.0273)	(0.0403)
Constant	0.0300	0.0590	-0.0162	0.1968 **
	(0.0375)	(0.0478)	(0.0703)	(0.0642)
R^2	0.0050	0.0041	0.0001	0.0053
Mean annual change	0.0868	0.0210	0.0007	0.2488
3. Clerical				
Δ Computer Use	-0.0928	-0.0326	0.0292	0.0831
	(0.0567)	(0.0262)	(0.0296)	(0.0543)
Constant	-0.0807	-0.1212 ~	-0.0647	-0.6700 ***
	(0.0960)	(0.0636)	(0.0809)	(0.1010)
R^2	0.0387	0.0106	0.0031	0.0165
Mean annual change	-0.2211	-0.0782	-0.0125	-0.6083
4. Craft				
Δ Computer Use	-0.0489 *	-0.0204	-0.0279	-0.0526 *
	(0.0209)	(0.0244)	(0.0307)	(0.0249)
Constant	-0.0362	-0.0101	-0.0064	0.0021
	(0.0521)	(0.0780)	(0.0970)	(0.0575)
R^2	0.0283	0.0046	0.0043	0.0172
Mean annual change	-0.1006	-0.1272	-0.2685	0.1005
5. Lower Blue Collar				
Δ Computer Use	0.0302	-0.0585 *	-0.0207	-0.0896 *
	(0.0440)	(0.0275)	(0.0335)	(0.0356)
Constant	-0.1964 ~	0.1218	-0.0722	-0.2219 *
	(0.1113)	(0.0908)	(0.0770)	(0.0952)
R^2	0.0058	0.0233	0.0018	0.0257
Mean annual change	-0.2680	-0.1586	-0.3280	-0.3448

Note: Both independent and dependent variables measured in percentage, not decimal, units. Annual changes in hours-weighted percentage of workers in each industry belonging to given occupation derived from Outgoing Rotation Group CPS files, 1984-1997. Change rates are regressed on industry-level changes in the percentage using a computer at work (October CPS files, 1984, 1989, 1993, 1997). All regressions weight by industry average share of total employment for the period and use robust standard errors. Sample sizes are 222 for first two columns and 221 for second two columns. "Mean annual change" refers to the simple, weighted annual change in the dependent variable. Agricultural, service, and technical workers not included in these analyses.

~ p<.10 * p<.05 ** p<.01 *** p<.001
Source: cps8.comp3c3.log, comp3d3.log

Table 6. Effects of Annual Change in Percentage Using Computers on Annual Change in the Percentage of Different Occupations within Manufacturing, 1984-1997 (Current Population Survey)

Dependent variable	1984-1997	1984-1989	1989-1993	1993-1997
1. Mgrs./Profs.				
Δ Computer Use	0.2086 ***	0.2595 ***	0.1050 *	0.1854 **
	(0.0484)	(0.0541)	(0.0492)	(0.0650)
Constant	0.1878 *	0.0845	0.0329	0.8341 ***
	(0.0804)	(0.1313)	(0.1342)	(0.1230)
R^2	0.2108	0.2177	0.0437	0.1113
Mean annual change	0.5240	0.4598	0.1501	0.9780
2. Craft				
Δ Computer Use	-0.0804 **	0.0245	-0.0501	-0.0641
	(0.0292)	(0.0498)	(0.0685)	(0.0425)
Constant	0.0647	-0.1053	0.0783	0.0718
	(0.0566)	(0.1254)	(0.1804)	(0.0835)
R^2	0.0506	0.0027	0.0065	0.0202
Mean annual change	-0.0761	-0.0678	-0.0392	-0.1297
3. Lower Blue Collar				
Δ Computer Use	-0.1130	-0.2571 **	-0.0438	-0.1034 ~
	(0.0723)	(0.0676)	(0.0637)	(0.0552)
Constant	-0.0581	0.4516 *	-0.3549 *	-0.2185 ~
	(0.1353)	(0.1893)	(0.1669)	(0.1277)
R^2	0.0443	0.1369	0.0051	0.0326
Mean annual change	-0.2379	-0.0975	-0.3271	-0.3242

Note: Both independent and dependent variables measured in percentage, not decimal, units. Annual changes in hours-weighted percentage of workers in each industry belonging to given occupation derived from Outgoing Rotation Group CPS files, 1984-1997. Change rates are regressed on industry-level changes in the percentage using a computer at work (October CPS files, 1984, 1989, 1993, 1997). All regressions weight by industry average share of total employment for the period and use robust standard errors. Sample sizes are 82 for first column, 81 for the second and fourth columns, and 80 for the third column. "Mean annual change" refers to the simple, weighted annual change in the dependent variable. Agricultural, service, technical, sales, and clerical workers not included in these analyses.

~ p<.10 * p<.05 ** p<.01 *** p<.001

Table 7. Effects of Annual Change in Percentage in Different Occupations on Annual Change in the Percentage Using Computers within Manufacturing, 1984-1997 (Current Population Survey)

Independent variable	1984-1997	1984-1989	1989-1993	1993-1997
1. Mgrs./Profs.	1.0106 **	0.8387 ***	0.4163 *	0.6002 **
	(0.2869)	(0.1996)	(0.1963)	(0.2125)
Constant	1.1045 ***	1.6726 ***	2.0590 ***	0.0980
	(0.1605)	(0.1676)	(0.1796)	(0.2659)
R^2	0.2108	0.2177	0.0437	0.1113
2. Craft	-0.6291 *	0.1087	-0.1290	-0.3157
	(0.2729)	(0.2264)	(0.1722)	(0.2116)
Constant	1.5978 ***	2.0534 ***	2.1635 ***	0.6373 **
	(0.1140)	(0.1578)	(0.1734)	(0.2236)
R^2	0.0506	0.0027	0.0065	0.0202
3. Lower Blue Collar	-0.3923	-0.5324 ***	-0.1157	-0.3155 ~
	(0.2769)	(0.1528)	(0.1721)	(0.1646)
Constant	1.5445 ***	2.0076 ***	2.1154 ***	0. 5827 *
	(0.1043)	(0.1484)	(0.2007)	(0.2384)
R^2	0.0443	0.1369	0.0051	0.0326

Note: Both independent and dependent variables measured in percentage, not decimal, units. Annual changes in hours-weighted percentage of workers in each industry belonging to given occupation derived from Outgoing Rotation Group CPS files, 1984-1997. Change rates are regressed on industry-level changes in the percentage using a computer at work (October CPS files, 1984, 1989, 1993, 1997). All regressions weight by industry average share of total employment for the period and use robust standard errors. Sample sizes are 82 for first column, 81 for the second and fourth columns, and 80 for the third column.

~ p<.10 * p<.05 ** p<.01 *** p<.001

Table 8. Trends in the Percentage Share of Specific Occupations Potentially Sensitive to Technological Change, 1971-1997 (March CPS)

Occupation	Percentage					Annual Change Rates		
	1971	1979	1982	1983	1997	1971-79	1979-82	1983-97
Sci./Technical								
Scientist/Engineer	2.62	2.69	3.15	3.15	3.91	0.01	0.15	0.05
Technicians	2.68	2.82	3.21	3.28	3.52	0.02	0.13	0.02
Computer Work								
Systems Analysts	0.10	0.28	0.35	0.32	1.16	0.02	0.02	0.06
Programmers	0.25	0.36	0.47	0.40	0.56	0.01	0.04	0.01
Retail Trade								
Cashiers (% of grocery workers)	17.79	24.30	25.08	29.60	28.96	0.81	0.26	-0.05
Clerks (% of retail/ wholesale workers	2.21	1.60	1.83	1.56	1.40	-0.08	0.08	-0.01
Clerical Workers								
All clericals	17.19	18.24	18.46	16.85	14.12	0.13	0.07	-0.20
Mgr./Cler. Ratio	1.45	1.47	1.57	1.58	2.22	0.00	0.03	0.05
All clericals (% of banking/insurance)	52.96	53.62	50.76	50.04	39.66	0.08	-0.95	-0.74
Secretaries	3.63	4.11	4.07	4.16	2.28	0.06	-0.01	-0.13
Mgr/Secty. Ratio	6.86	6.53	7.11	6.38	13.75	-0.04	0.19	0.53
Tellers (% of bank workers)	20.62	25.33	23.62	19.78	18.03	0.59	-0.57	-0.13
Postal Clerks (% of postal workers)	37.52	36.06	39.28	34.56	33.50	-0.18	1.07	-0.08
Telephone Work*								
Operators	21.35	14.36	12.51	6.82	3.94	-0.87	-0.62	-0.21
Installer/Repairer	31.86	30.91	28.44	26.34	17.41	-0.12	-0.82	-0.64
Auto Workers*								
Assemblers	14.95	18.60	14.66	15.90	20.42	0.46	-1.31	0.32
Welders/Painters	6.95	8.29	5.61	3.97	7.59	0.17	-0.89	0.26

Note: All figures weighted by hours worked in previous week. Unless otherwise indicated, all figures are percentages of total workforce.

* These percentages represent the share of the occupation within this industry only, not as a share of all workers.

Figure 1.

Trends in the Variance of log wages, 1979-97 (CPS-Outgoing Rotation Group files)

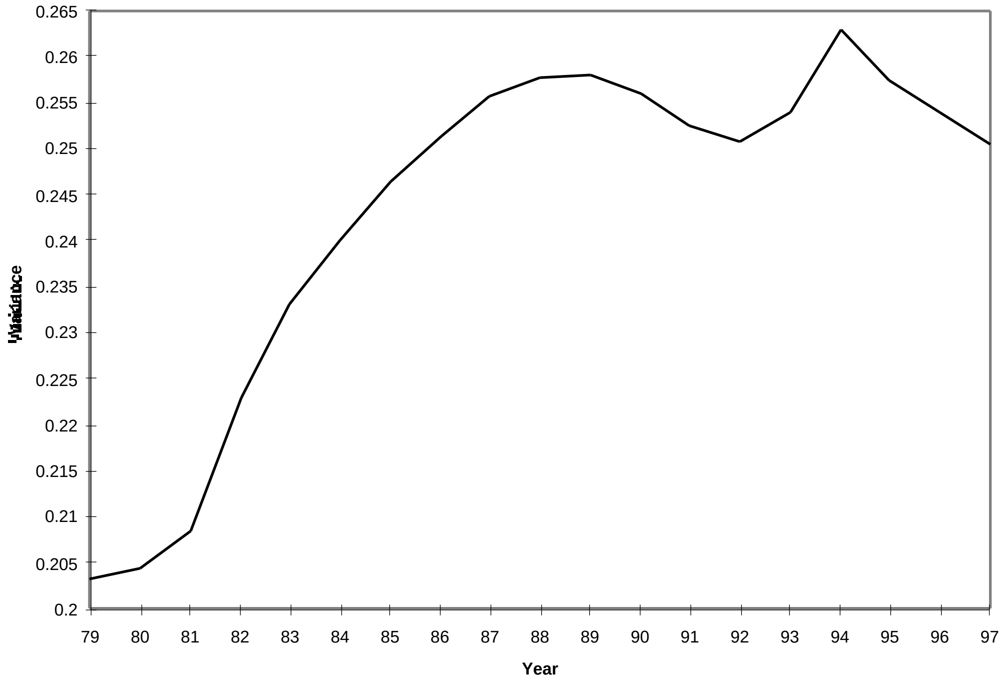


Figure 2.

Figure 1. Trends in Mean Educational Attainment of Workers,1962-97
(March CPS) (figures for 1992-97 are imputed from categorical responses)

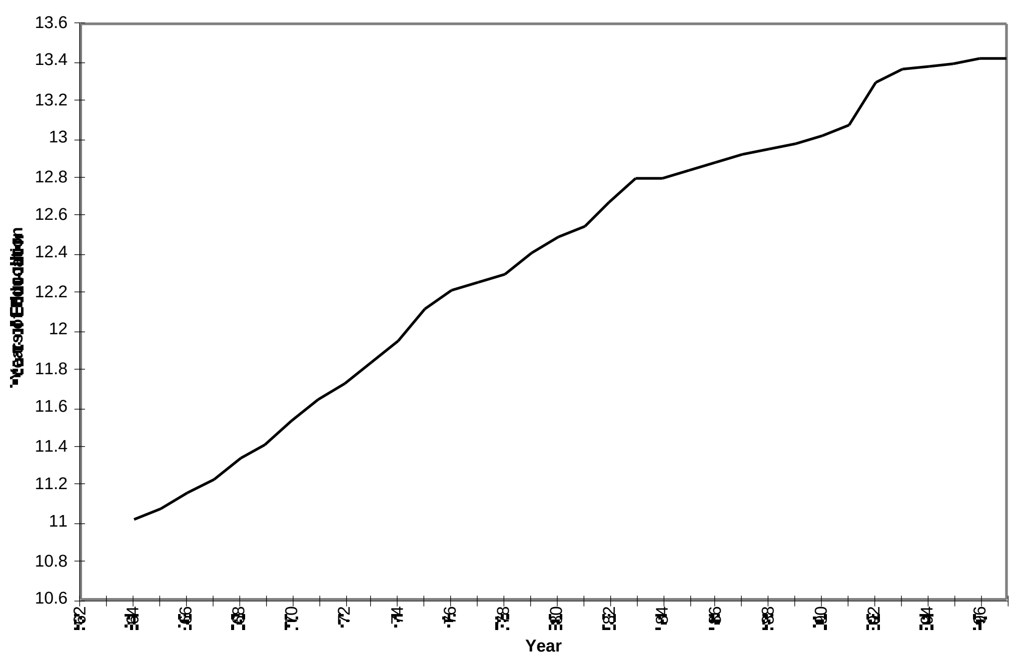


Figure 3.

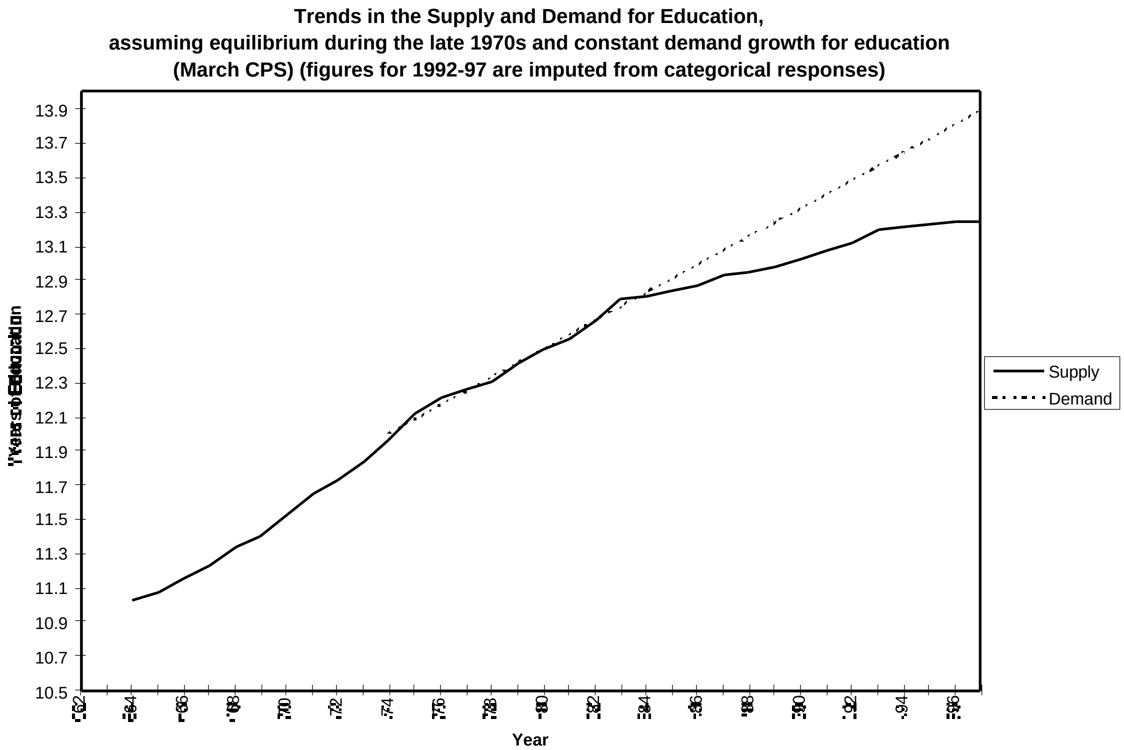


Figure 4.

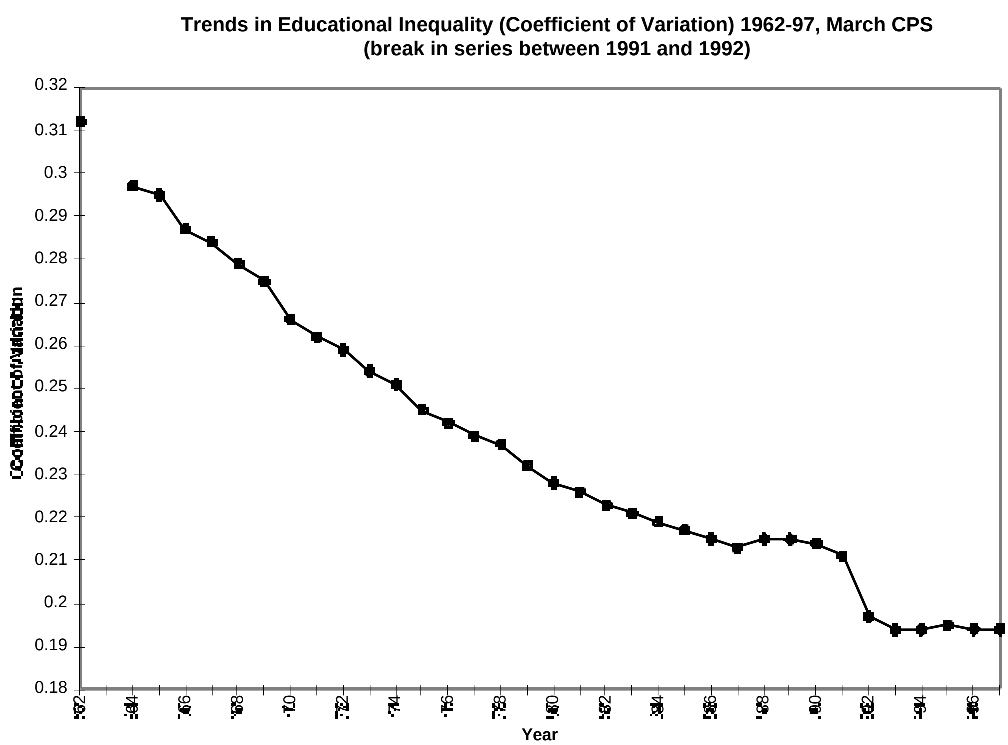


Figure 5.

Figure 6.

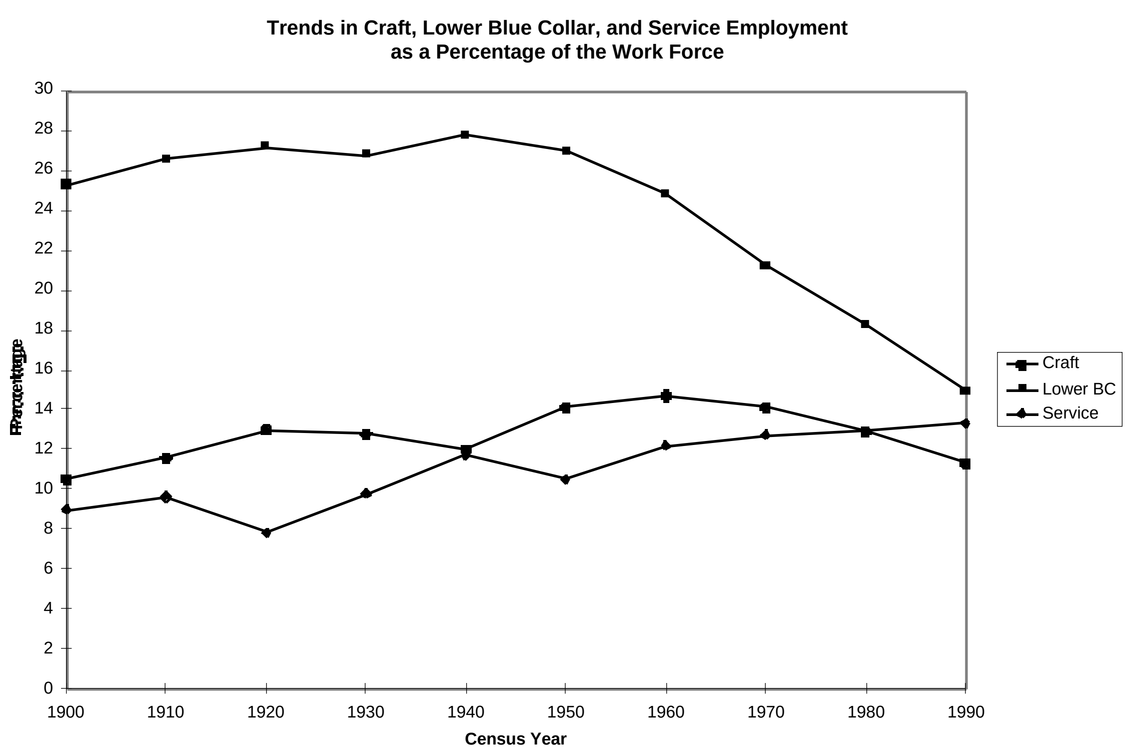


Figure 7.

Trends in Farm Occupations as a Percentage of the Workforce

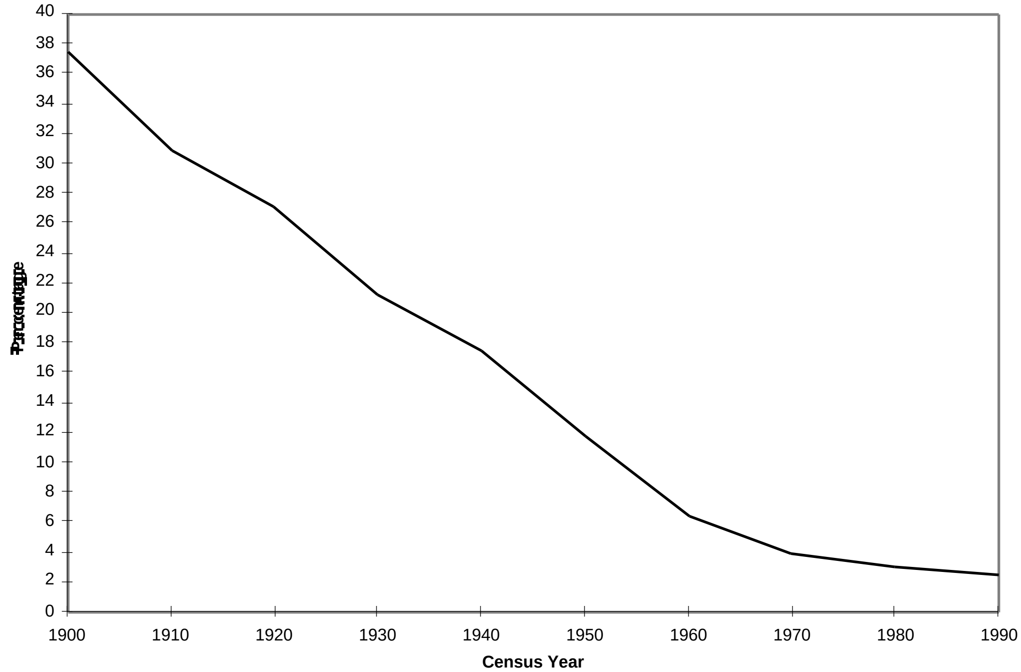


Figure 8.

Trends in the Shares of Craft, Blue Collar, and Service Workers as Percentages of the Work Force 1962-1997, March CPS
(breaks in series between 1970 and 1971 and between 1982 and 1983)

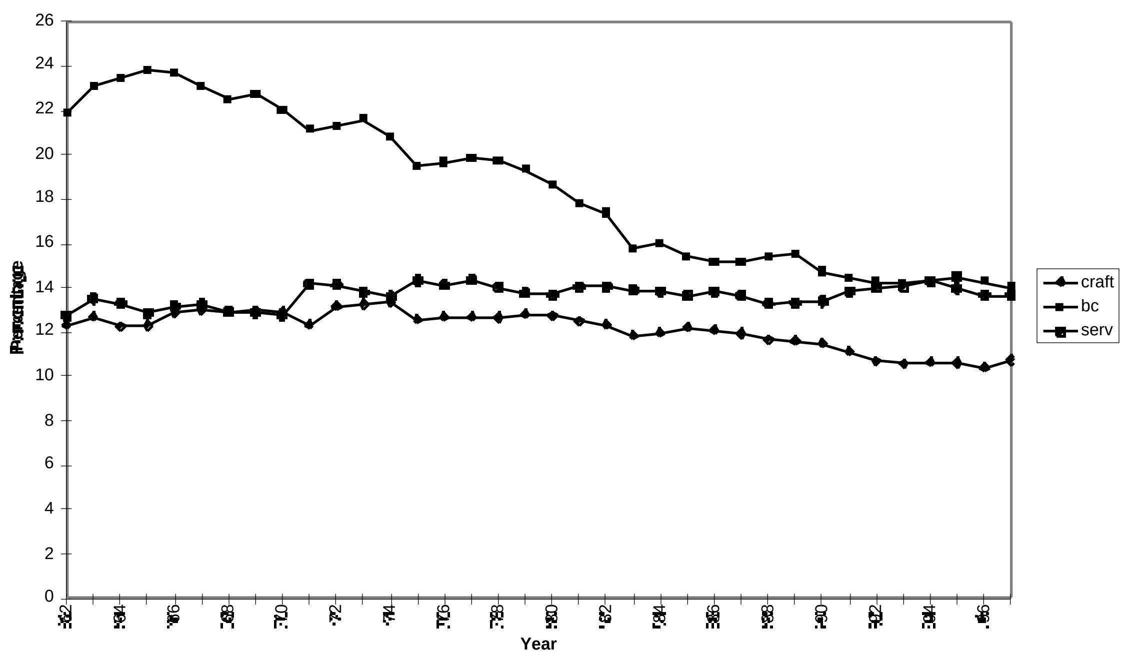


Figure 9.

Trend in the Share of Blue Collar Workers in Manufacturing 1962-1997, March CPS (break in series between 1982 and 1983)

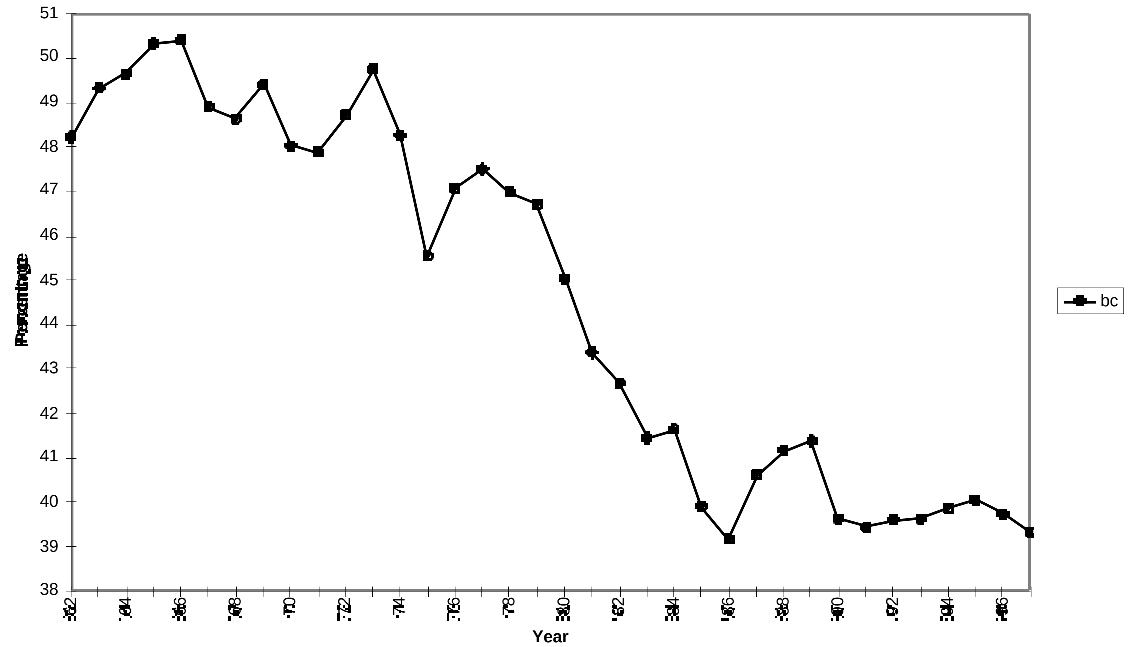


Figure 10

Trends in the Ratio of Blue Collar/Non-Blue Collar Weekly Wages and Percentage of Blue Collar Workers within Manufacturing, 1975-96 (March CPS) (Hours weighted)

Figure 11

Trends in the Ratio of Blue Collar/Non-Blue Collar Hourly Wages and the Percentage Share of Blue Collar Workers within Manufacturing, 1962-96 (CPS ORG) (Hours weighted)

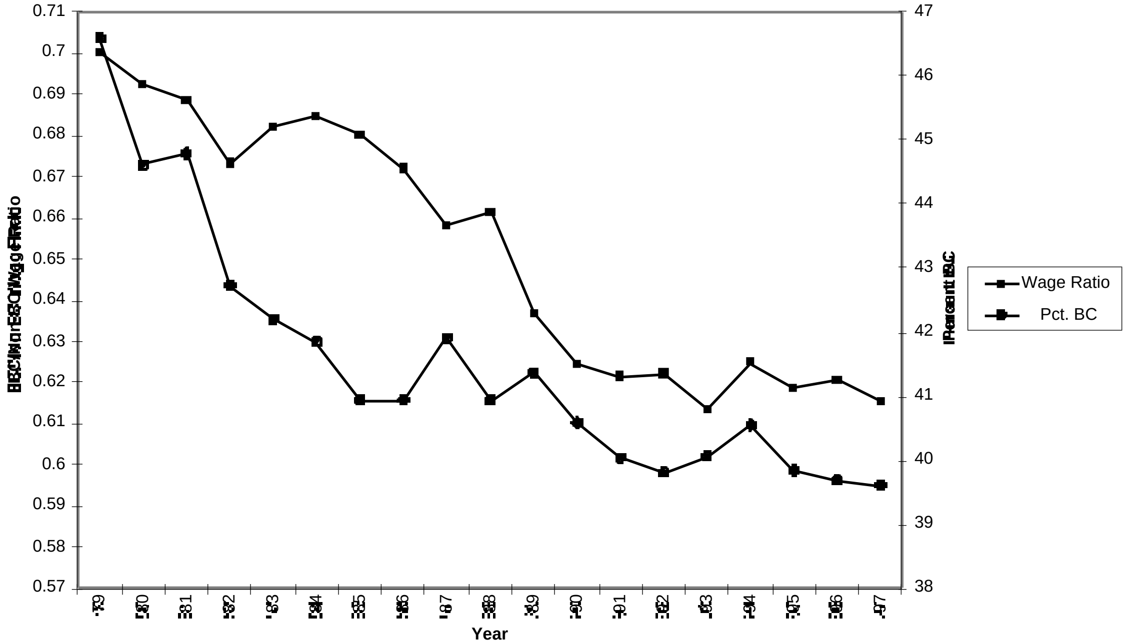


Figure 12.

Trends in the Share of Clerical Workers as a Percentage of Workers in Finance and Insurance Industries (avg. n=2,787), 1971-97 (March CPS)

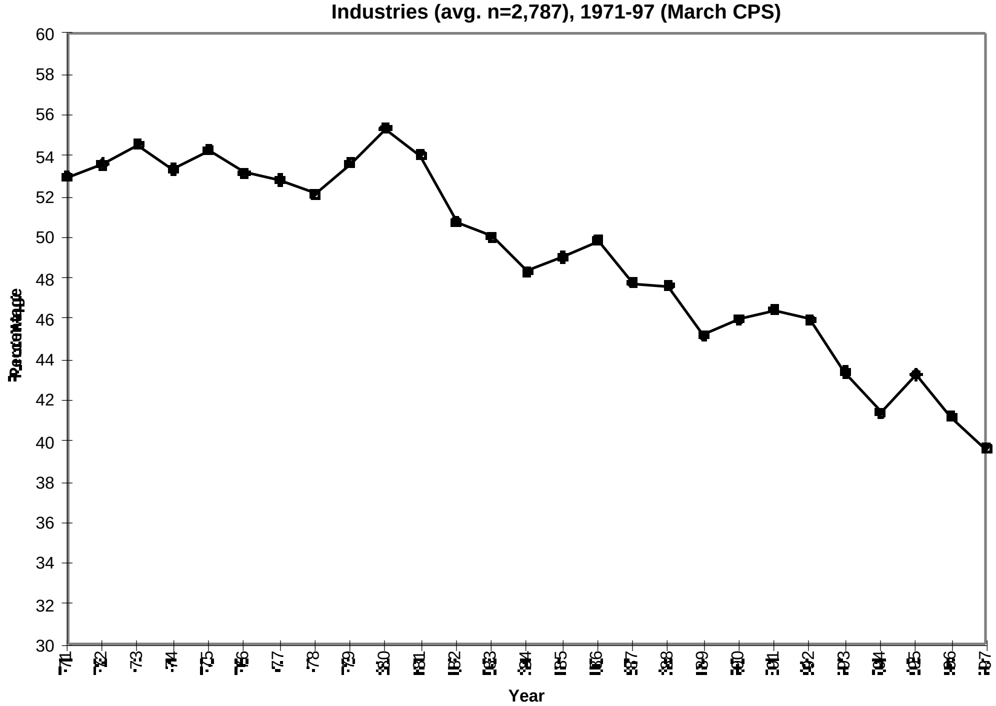
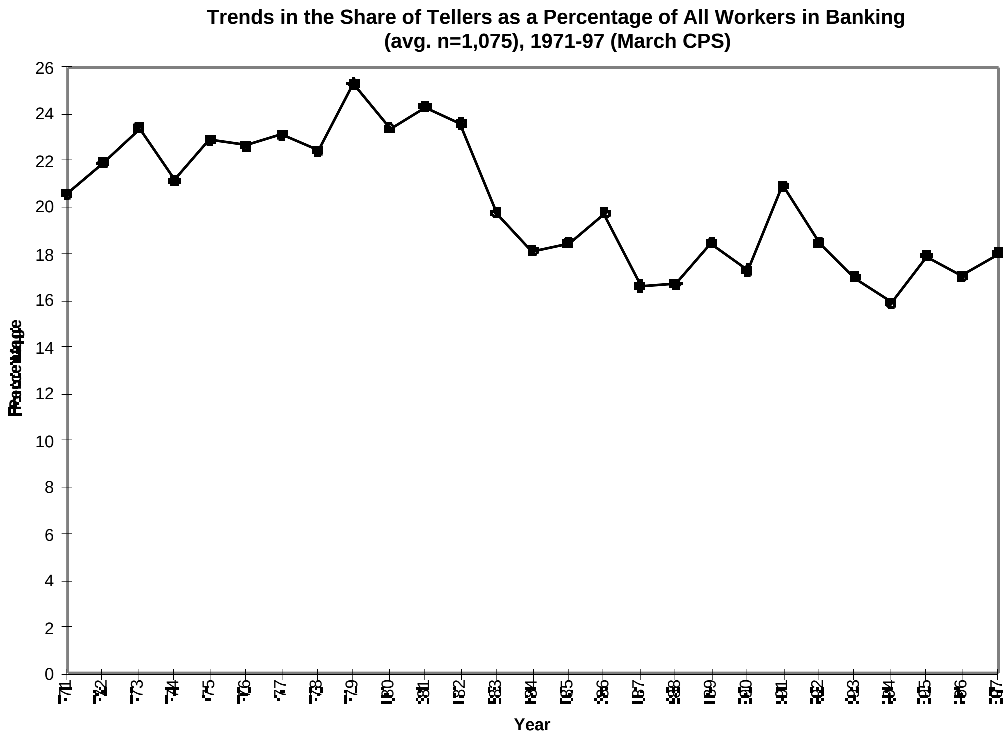


Figure 13.



Trends in the Share of Tellers as a Percentage of All Workers in Banking
(avg. n=1,075), 1971-97 (March CPS)
Percentage
Year